The Gardens' Bulletin
STRAITS SETTLEMENTS,

Vol. II Issued November, 11th 1918. No. 3

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To be purchased at the Botanic Gardens, Singapore; from Messrs. Kelly and Walsh, Ltd., No. 32 Raffles Place Singapore.

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DEPARTMENTAL NOTICES.

A new List of Plants, which may be purchased from the Botanic Gardens, Singapore or Penang, is in the press.

Requests for yams should be received at once.

Plants of the Avocado or Alligator Pear—*Persea gratissima*,—and Brazil nut—*Bertholletia excelsa*,—to be sold within the Peninsula at fifty cents each.

Seeds of *Hevea brasiliensis*—Para Rubber—as available from trees, twenty-eight years old, to be sold at three dollars per thousand up to the number of ten thousand, and at two dollars and fifty cents for every further thousand on the same order.

The Gardens' Bulletin is published as material becomes available. Its price is fifty cents a copy, post free, or in advance for a volume of twelve numbers, post free,

Five dollars in the Straits and Federated Malay States.

Nine and a half rupees in India and Ceylon.

Thirteen shillings in Europe.

Hibescus Sabdriffa, a crop raised in the Economic Garden, Singapore.

PLATE V.

THE

GARDENS' BULLETIN.

STRAITS SETTLEMENTS.

Vol. II. Issued November 11th. No. 3

THE ROZELLE—HIBISCUS SABDARIFFA.

In March, 1916, seeds of several races of the Rozelle were received in the Botanic Gardens, and in 1917 one of them,—a race called "Archer"—gave in the Economic Garden the splendid crop here figured. It was the second generation of the race grown in Singapore.

As the Rozelle has been described in the *Agricultural Bulletin of the Federated Malay States* so recently as 1913 (J. Lamborne, in vol. II, p. 57) no general account is called for here: but the means by which this enormous crop was got will be detailed. The seedlings were raised in seed pans and were planted out on low ridges two feet apart, the rows being three feet apart, in March. The planting was too close and there appeared no signs of fruit for a long time. Then to hurry the plants every other row was removed in July, and every other plant in the rows, whereupon the flowering commenced.

Before this happened plants which had been grown in pots had produced a small crop of fruits—say 25 to a plant,—at 6 months and had died. What they produced was not a tithe of what the bed outside produced. The excellent result with it is ascribed to the conditions having caused the flowering to be held back until the full vegetative vigour of the plants was established. In pots flowering commences while the plants are weak.

No records were kept of the return; but the photograph was taken when the plants had already been much picked over.

Jelly was experimentally made and with success, and fruit widely distributed in Singapore.

"Archer" is a white-fruited race. Therefore a little cochenille is desirable in the jelly to improve its appearance when it is intended to be used as an alternative for Red Current Jelly.

Mr. P. J. Wester in the Philippine Agricultural Review, VII, 1914, p. 267, says he had received the race "Archer" from Mr. A. S. Archer, of Antigua, British West Indies, in 1913.

I. H. Burkill.

NOTES ON COLA TREES IN THE ECONOMIC GARDEN, SINGAPORE.

In the Economic Garden are to be found fourteen trees of the genus *Cola*. There were more: but the plantation, on the hill top, which grew badly was in chief part removed in 1917. Five of the trees are thick and bush like, 7—8 feet high, their branches dense and entangled, and carrying leaves down to the ground: they belong to the species *C. acuminata*, using the name as used by MM. Chevalier and Perrot in their "Végétaux utiles de l'Afrique tropicale française," VI, 1911. The other nine trees, judging by their bearing, belong to the species *C. nitida*: but as yet the flowers and fruits of one only have come under observation for full determination. They are 30-40 feet high, with rather sparse branches and foliage. All have suffered from the poorness of the soil and from want of manure. They have fruited at times; but, with the one exception, not in 1918. The tree that has fruited and on which most of the following observations have been made, is 40 feet high; its fruits were ripened continuously through May, June and July to the number of about 130, which contained 314 seeds—the Cola nuts of commerce. This is by no means its first crop; but it is the first that has been systematically harvested. The history of the tree is unknown. The records of the Botanic Gardens show that Cola was introduced in 1879 (Report for that year, p. 3), and again in 1881 from Kew (Report for 1881, p. 6), and again from Kew in 1893 (Report for 1893, p. 2). In the Report for 1884, it is recorded that the "African Cola nut planted in the Experimental nursery.....grew well in the alluvial soil there." Now Cantley's Experimental Forest Nursery was on the alluvial soil of the Economic Garden, and it is quite evident that the tree or trees to which his report referred, were where the Colas—some of them—are now; but it is difficult to make a connection between any of them and Cantley's statement. One Cola tree in that neighbourhood flowered but did not fruit in 1892 (Report for the year, p. 2). In the year 1907 a tree, probably the same one, fruited heavily; and, if the memories of men who have served long in the Gardens are to be trusted, that tree was the one which has fruited in the current year. It is *Cola nitida*: and therefore the introduction of Cola seed in 1881 would probably be of *C. nitida*. The entry is of "Cola acuminata," a consequence of the confusion which has existed in the nomenclature of the Colas, whereby more than the true *C. acuminata* passed under that name.

Chevalier and Perrot explain the nomenclature thus. Ventenat, while employed in describing the plants cultivated in the gardens of the Malmaison palace, examined the dried material in the Herbaria available to him, and found what he considered to be, as others also would have done at the time, a *Sterculia* cultivated in Mauritius, and new to science. He described this plant as *Sterculia nitida*, the description appearing in 1803. At a little time before this, Palisot de Beauvois had been in Benin and had got another plant which he described, about the same time, *i.e.* in 1803,

as "Sterculia acuminata," and which, he said, gave the Cola nuts of Sierra Leone. Now, say MM. Chevalier and Perrot, the one Cola of Benin is not that which gives the Sierra Leone nut, whereas the plant, which Ventenat had from a garden in Mauritius, is: so that Ventenat had described as *Sterculia nitida* the true Sierra Leone Cola without knowing that he was doing so, but Palisot thinking he was, was in reality fixing the nut of commerce on to a wrong tree which he was calling *Sterculia acuminata.* Not long after this the Colas were separated from the Sterculias and *Sterculia acuminata* became *Cola acuminata,* while *Sterculia nitida* became *Cola nitida.* MM. Chevalier and Perrot maintain that, the last is the right name for much that has passed as *C. acuminata.*

According to this classification, *C. nitida* embraces the Colas having only two cotyledons, whereas *C. acuminata* refers to the Colas having more than two cotyledons.

The nuts with two cotyledons are reputed to be the best, and the Natives of West Africa, where the Cola nut is largely consumed prefer them to the polycotyledonous ones, and pay more for them.

Three varieties of *C. nitida* are mentioned, viz:

1st. *C. nitida, alba* which produces white nuts.
2nd. *C. nitida, rubra* which produces red nuts.
3rd. *C. nitida, mixta* which produces both white and red nuts.

The tree, which we are dealing with at present, belongs to the last variety; for although by far the greater number of the nuts were found to be of a light pink, almost white, tint, some were also found of a deep ruby colour, or of a wine-purple colour.

The piece of land, in which it grows, with three others of its kind, adjoins the present vegetable growing plot; it had been left in recent years untilled; but in February last, it was taken in hand, stumped, cleared and dug: the present crop is perhaps the response to this beginning of cultivation.

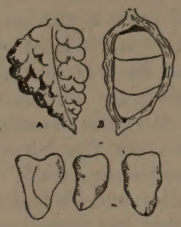
Be this as it may, the tree has given a crop, and following upon the further cultivation and manuring which it has since received, along with its three companions, we may reasonably look forward to an increased crop towards the beginning of next year, as the Cola tree gives two crops a year.

The Cola Nut.

The fruit on the tree is a rugged warty green pod, some 2 to 4 inches long, and about 2 inches in diameter—more or less egg-shaped, but terminating with a point slanting to one side.

The pods open a few hours after falling from the tree; but several were collected already open, showing through a slit the white waxy seeds inside. The number of the seeds varies, as far as I have observed, from one to five, the latter rarely, and the average being three. The sketch attached is a reproduction, as

well as I can make it, of the largest fruit amongst those which were gathered.



Fruit, fruit in section, and seeds of *Cola nitida*, one quarter natural size.

The seeds are surrounded by a tegument of cream-coloured waxy pulp resembling that of the durian, and which is sweet and not unpleasant to the taste. This sweet waxy pulp is very attractive to ants which, as soon as the pods open, quickly dispose of it.

When kept stored for a couple or three days, the pulp gives off, in the process of fermentation, the sweetish smell which is characteristic of alcoholic fermentation, and this leads me to believe that, like other substances containing sugar, alcohol could be obtained by the distillation of the pulpy tegument. This has a bearing on the possibility of Cola as a remunerative cultivation of the future, as, in the case of alcohol being obtainable from the pulp, a ready and inexpensive means would be at hand for making locally the extract of Cola from fresh nuts, which contain all the valuable principles of the nut, instead of shipping to Europe more or less mouldy nuts with a loss of much of their active principles, as I shall presently show.

The nuts are very irregular in size and in shape: and the manner in which they are wedged one against the other in the shell varies also greatly.

The same remark applies to the arrangement of the cotyledons which are packed together in the most intricate convolutions, one sometimes almost encircling the other.

After they have been divested of their sweet pulp, which rubs off easily, the seeds are found wrapped up in a thin papery envelope, which, like the pulp, is easily detachable. The naked seed then remains, of a fresh light pink colour, with slightly outlined brown wavy lines, which mark the line of division of the two cotyledons. A few of the seeds are of a deep ruby or purple colour; but they are otherwise indistinguishable from other seeds, although I have seen it stated that such nuts, as well as the pure white ones, are preferred by the natives of Africa.

After a week's exposure in a well aired place on my verandah, the nuts, previously divested of their envelopes, began to open, just like an oyster would, the two cotyledons parting slightly; and, with a little effort, they can then be completely separated from each other. If left in that state, that is to say, only partly opened, it is found that mould collects in the centre of the nut, at the point

of attachment of the two cotyledons, instead of on the surface, from the fact, no doubt that the inner moisture of the nut finds an exit at that central spot, where for lack of ventilation, mould gathers. This explains the practice of shipping to Europe nuts which are split in halves, so as to avoid the gathering of mould between the cotyledons and, hence it is that we see in the records of sales of Cola nuts, as in the Trade Report of the "*Chemist and Druggist*" of May 11th, 1918, the following:

"*Cola.* 3 bags of fair dried Jamaica *halves,* sold at 11 pence, "being about steady.—207 bags slightly mouldy African qualities "were limited at 11*d.*"

The storage of Cola nuts offers some little difficulty, as, oxydation keeping pace with dessication, the nuts become not only lighter and lighter in weight, but they also take a very dark colour, and are apt to become the feeding-ground of a tiny, but fat, white maggot, which riddles the surface of the nuts with wavy furrows and renders them "*wormy*"—greatly depreciating their value. The best way to preserve the nuts in a fresh state, as far as I can judge, is to put them in air-tight tins, and to give them an airing once a week. By this means, the nuts do not lose weight so fast, and they keep their pink colour longer; but after a month, brown spots appear and the nuts, bye-and-bye, assume the objectionable dark colour. The problem of landing nuts in Europe in the fresh state, can be, it is said, solved by sterilising the nuts, but I am not aware that this is carried on to any extent, and, at any rate, it must result in a big increase in the cost of marketing the nuts.

My weighings of Cola nuts, fresh and dry, give the following figures:

18	fresh large nuts weigh ..	..	16 ounces.
21	„ medium „ ..	..	16 „
24	„ nuts at random ..	..	16 „
26	nuts after 6 days' drying	..	16 „
32	„ „ 3 weeks „	..	16 „
33	„ „ „ „	..	16 „
36	„ „ 4 weeks „	..	16 „
40	„ „ 45 days „	..	16 „

These weights do not agree with those given by August Chevalier and Perrot, who put down 12 grammes as the average weight of fresh nuts, which would make about 39 required to the pound. But the nuts referred to in their book are from Dahomey or French Guinea and therefore not *C. nitida;* and it is stated that the nuts of the Ivory Coast, where *C. nitida* occurs, are larger and weigh on the average 25 grammes *i.e.* about 18 to the pound.

The active principles of Cola, on which depend its physiological and stimulating properties are:

1st. Caffeine of which it contains from 2% to 2.5% *i.e.* much more than coffee itself.

2nd. Theobromine, the alcaloid found in the cocoa beans.

3rd. Kolatine, a substance as yet imperfectly known.

4th. Betaïn, an alcaloid found in beet and other plants "slightly diuretic and non toxic" (Henry).

The Cola nut contains moreover a large amount of starch, *i.e.* about one third of its weight which gives it a high nutritive value. As a matter of fact, it is largely used as a food in Africa, mixed with milk and honey. In Jamaica it is used as cocoa and chocolate, prepared by grating the dry nut into powder and mixing in boiling water, with milk and sugar. "Some people use the Cola "nut regularly at breakfast in this manner, and consider it superior "to everything else of the kind." (Kew Bulletin, 1890).

Chemical Composition.

The chemical composition of Cola nuts, dry and fresh, is variously given, as follows:

	Water	Free alcaloid	Combined alcaloid	Total
By Knox and Prescott:				
Dry nuts	6.16	1.84	1.82	3.66
Fresh nuts	53.90	1.15	1.92	3.07

	Water	Free alcaloid Caffeine	Fatty matter	Ash
By Dietrich:				
Dry nuts	13.86	1.77	1.67	2.50
Fresh nuts	57.29	1.43	3.33	1.56

	Free alcaloid Caffeine
By Ballande:	
Dry nuts	3.11
Fresh nuts	2.75

Dr. Frankland Dent, Government Analyst, Straits Settlements, who kindly undertook the analysis of four nuts from the Economic Gardens, found that they contain:

Water 42.76%

Caffeine containing a trace only of Theobromine, calculated on the dry sample 1.61%

It should be stated that these nuts were not fresh from the tree, but had been kept for some time in a closed tin, which would account for the water-content being lower than appears in the above analyses.

Referring now to the weight of nuts, dry and fresh, in my weighings as given above, which average:

fresh 21 nuts to 16 ounces or 454 grammes
dry 33 nuts to 16 ounces or 454 grammes

it will be found, according to the figures of Knox and Prescott, that:

	grammes.
100 fresh nuts weighing 2162 grammes contain of Caffeine free and combined	66.37
100 dry nuts weighing 1375 grammes contain of Caffeine free and combined	50.36

100 dry nuts, therefore, lose in the process of drying of their free and combined alcaloids 16.01

The drier the nuts, the greater the loss.

This would be the actual loss on nuts dried locally, but otherwise sound. What the loss may be after a week or two in the hold of a ship—with the additional deterioration caused by mould, I have no means of knowing.

The number of dry nuts, viz: 33, on which the above calculation is based is the number of nuts to one pound weight, after 3 week's drying—*i.e* a period that corresponds to the length of the voyage from the African Coast to Europe. But the degree of dessication can go much further, for I have found that after a couple of months as many as 100 halves (= 50 whole nuts) go to one pound.

On the other hand, reverting to the previous figures, 100 fresh nuts would have to pay freight (57.30%) on 1238 grammes of water—where 100 dry nuts would only pay (13.86%) on less than 200 grammes. In other words, one ton of fresh nuts would pay for more than half a ton of water—whereas one ton of dry nuts would only pay on about 3 hundredweight. Whether the gain in alcaloids, in shipping fresh nuts, would not be balanced by this surplus on freight, is a question which, for the present, must remain open.

Trade.

The uses to which the Cola nut is put in Europe and America are many and varied. It enters in the composition of tonic wines and liqueurs—of confectionery, of chewing gums, in certain well-known therapeutic preparations: a use is found for it in dysentery, combined with bismuth and salol as, "with this medicine a patient "can go a considerable time without food and thereby the stomach "obtains its needed rest." (*"Chemist and Druggist,"* 20th Nov., 1915.)

But the greatest use to which the Cola nut is put is for mixing with cocoa, a use for which it is especially well adapted, as, owing to its small content of fatty matter (only 1.67% of the dry nut), it forms a very suitable mixture with the powder of the cocoa bean; the latter containing an excess of fat, or cocoa-butter, which has to be removed in the manufacture of pure cocoa. I presume that it is to this capacity of being used as a part substitute for Cocoa, and to the increased demand created thereby, that the present favourable position of the Cola market is mostly due.

But it is impossible to say how far war conditions have shared in this advance, as the export figures (see below) do not carry us beyond 1915, and, moreover, they do not discriminate between the exports to Europe, and the Coastal exports to the neighbouring French and Portuguese Colonies, which, we know, are very important.

Freights must have influenced the rise in prices, but, even computing on a freight of two pence per pound, the margin between pre-war prices ($1\frac{1}{2}d$ to $3\frac{3}{4}d$ per pound) and the actual price of 11

pence per pound in May, 1918, is so great, that it can only be the result of a vastly increased demand, coupled with a higher grade of the nuts shipped to Europe. This is borne out, I think, by the description of the nuts marketed since 1915, which are no longer catalogued merely as "dark, mouldy or wormy," but as "good bright halves," or "fair dried halves."

How far this increased demand will persist after the war, the future will decide, but it is not unlikely that when the valuable properties of Cola are better known in Europe, the demand for it will expand more and more.

But, be this as it may, the chief mainstay of the prosperity of the Cola planting industry will yet remain, for a long time to come, what it is now,—viz: the Native African consumption, which far exceeds the boundaries of the Countries of production; for the use of the nut is fast spreading to all the Mussulman lands of Northern Africa and it has found its way to Morocco—Algeria—Egypt—Tripoli and as far as Turkey and Malta.

The figures below show that the trade in Cola nuts is taking a greater extension every year. It stands, now, second (after Cocoa) on the list of the exports of the Gold Coast, the figures for the last six years given by the Report of the Government of the Gold Coast being as follows:

							d.		
1910	5,156,500	pounds	value	£	77,716	or	3.6	per	lb.
1911	5,791,931	„	„	„	93.099	„	3.85	„	„
1912	7,133,165	„	„	„	134,231	„	4.32	„	„
1913	7,024,866	„	„	„	144,705	„	4.94	„	„
1914	7,862,414	„	„	„	142,190	„	4.34	„	„
1915	8,267,100	„	„	„	139,163	„	4	„	„

The last figures for Sierra Leone that I can find relate to the year 1909 when (exclusive of exports to Europe) the exports to the neighbouring French and Portuguese Colonies amounted to 1444 tons of a value of over £100,000.

Cola nuts also occupy the second place, after palm-kernels, in the exports of Sierra-Leone.

In his book "*Sierra Leone; Its People and Products,*" Osman Newland states that at Freetown, the price of the nuts varies from £6.10 to £13 per measure of 176 pounds, which corresponds to a price of $8\frac{3}{4}d$ to $17\frac{1}{2}d$ per pound and he adds: "the annual value of "the Kola nuts exported exceeds £100,000, but only the throw-outs "and undersized nuts reach Liverpool or London, where, selling at "$2\frac{1}{2}$ to $4d$ per pound, they are used as an adulterant for cocoa."

In Lagos, according to Dudgeon (Imperial Institute handbooks) the price paid for nuts varied from 1*s.* 3*d.* to 5 shillings per hundred i.e. from 3d to 11d per pound, but in 1907 the value reached £150 per ton, i.e. 16 pence per pound.

The higher prices must be understood to apply to fresh nuts which are used locally by the natives, and by the neighbouring colonies where a huge and constant demand exists, keeping pace

with the enormous production, which is said to be about 20,000 tons.

The market quotations of the Cola nut in Europe have been subject to somewhat remarkable ups and downs, as will be seen from the Trade Reports of the "Chemist and Druggist" which are extracted at random from old numbers of that paper.

1890 October 18. Kola nuts have much advanced this week, and in Liverpool, up to 2/9 is now asked for good dry seeds.

1909 December 25. The lower prices now range from 56 to 60 marks per 100 kilos on the spot (Hamburg).

1913 November 29. Kola slightly easier 3*d* to 3½*d* was obtained for fair small to bold dried West Indian. 2½*d* for darkish slightly wormy and 2*d* for dark mouldy.

1914 June 13. Kola 3 bags dark Ceylon sold at 2½*d* per pound.

1914 December 19th. Kola. At the spice auction, 4 barrels dried sold at 1½*d* to 1¾*d* per pound.

"The Chemist and Druggist Diary 1918" gives the following under:

Cost of Drugs and Chemicals during the War.

Kola	January 1	Dec. 31	June 30	Dec. 31	July 31
West Indian	1915	1915	1916	1916	1917
per pound	3*d*	4¾ to 6*d*	5¾ to 6*d*	6*d*	5 to 6¼*d*

For the present year, the prices stand as follows:

1918 April 13. Kola sold at slightly firmer prices from 10*d* to 11½*d*, the latter price being paid for 74 bags West Indian for good bright halves and wholes.

1918 May 11th. 3 bags of fair dried Jamaica halves sold at 11*d* being about steady—207 bags slightly mouldy African qualities were limited at 11*d*.*

The above quotations confirm what I have already pointed out, viz: that up to 3 years ago, the bulk of the exports to Europe mostly consisted of more or less old, dark and mouldy nuts, of "throw-outs," as Newland puts it; and that since 1915, the demand of the European and American market, has been for a greatly improved staple of nuts.

Incidentally, they point to the conclusion that, though very much higher than in previous years, the prices are not yet high enough, taking into account abnormal freights, insurance &c., to secure the very best nuts, which the native insists upon having fresh, and sound, and for which he is prepared to pay the price.

Cultivation and Yields.

The most important centres of production of Cola nuts seem to be the countries skirting the Western African Coast between,

* The latest record to hand of the Cola market "Chemist and Druggist" of 3rd August is "Kola, 20 bags part mouldy "quarters" were held for 10 pence.
The designation "quarters" applies to the separated cotyledons of the nuts of *C. acuminata*, which have more than two cotyledons.

and including, the Cameroons to the East, and Sierra Leone to the West. In these, countries, it grows under the conditions inherent to native cultivation. It is however, cultivated to a certain extent in Jamaica where it was brought, some eighty years ago, by slave ships. It is therefore fully acclimatised there, and it thrives quite as well as in its own habitat—and an export trade of some importance has been established. It is also cultivated, on a small scale in other islands of the West Indies, in the French Antilles and, also, I believe, in the island of Bourbon. The exports from Java to the Netherlands amounted to: 10937 Kilos in 1909,—13000 Kilos in 1910,—11000 Kilos in 1911 (van Gorkum).

But, except in the case of one Company in the Gold Coast territory, and one in Sierra Leone, I am not aware that the cultivation of Cola has been anywhere undertaken on a large scale, under systematic conditions, such as obtain on our large estates of rubber, cocoa or tea; it seems, so far, to have escaped the keen attention of the planter. Yet, we are not without some data as to its behaviour under cultural treatment. Mr. W. Fawcett, a well-known authority on things Jamaican, speaking from experience, states: " that the Cola tree is propagated from seeds and will begin " to bear after four or five years. There are trees near the Botanic " Gardens at Castleton, which were planted over 50 years ago, still " in perfect health, and bearing fruit regularly." This was written nearly forty years ago.

" The trees should be planted about 20 feet apart.....they " grow about 40 feet in height. Those near Castleton produce " from 500 to 800 pods each crop. If each pod contains, on a " moderate calculation, four seeds, and if we say 50 seeds to a " quart—then a tree with 600 pods will give 50 quarts of nuts twice " a year, or 100 quarts per tree per year (there are two crops in a " year). A quart of dry nuts will weigh a little over 1¼ pound = " 125 pounds per tree. A tree in full bearing, and under careful " cultivation, would probably produce 150 pounds of nuts a year" (Kew Bulletin, 1881).

It will be noticed that in the above statement *dry* nuts are specified. The weight of fresh nuts would be about one quarter to one third more.

In the Cameroons, we are told, one hundred trees were planted in 1904, and manured later on, with the result that the trees were in fruit in 1907, and in 1908 the crop was abundant.

In Western Africa, according to various authorities, the gross output of a tree varies in value from 20 francs, in bad years; to 75 francs in good year. In the Cameroons, Dr. Bernegau puts the money value of the crop at 50 marks per year per tree. Newland puts it at 30 shillings in Sierra Leone, and he adds: " Under " proper cultivation a Cola tree should yield double that revenue." i.e. 60 shillings.

The report of the Agricultural Station of Tarquah (Gold Coast) issued by the Government of the Gold Coast, for 1915, says: " The station has 29 acres under Kola, planted in 1909. The " majority of the trees have made excellent growth: the oldest trees

"fruited freely, and 278605 nuts were harvested up to the end of "the year."

These facts, and many others which could be adduced, if space permitted, dispose of the pessimistic outlook of the authors of "Les Noix de Kola et les Kolatiers" as regards the prospects of the Cola tree, as a remunerative, though perhaps, for the present restricted industry. That the trees yield profitably before their fifteenth year is quite satisfactorily established.

That many trees never bear fruit, or very late is not surprising, given the localities in which the authors have mostly seen such trees *i.e.* in dense, overcrowded forest thickets. Planters would find a way to improve upon such conditions, and to provide their trees with the conditions of location, of soil and moisture, supplemented, if necessary, with manures, required for the well-being of so valuable a crop.

We have some indications of what these conditions should be, from the accounts given us by many competent observers.

Mr. Elliott, Forest Officer, Northern Nigeria, says of the nuts found in the Province of Nupé, Northern Nigeria, "this nut is in "great demand throughout the whole of North Africa, and it "fetches locally almost double the price of the kind with 4 or 5 "cotyledons. The trees grow in sheltered valleys at an elevation of "from 450 to 550 feet above the sea. The soil is a deep, black, "sandy loam and is kept in a continuous state of moisture by the "streams that are found in each valley." (Kew Bulletin, 1906, No. 4).

That the Cola tree is a grateful tree under kindly treatment is also evidenced by the following statement of Mr. Dawodu in his report of his tour through the Lagos hinterland, at the request of the Government of Lagos in 1898.

"The Kola tree abounds in these parts. The trees were all in "a most flourishing condition, always bearing heavy and abundant "crops. Indeed, the Ekiti Country is famed for its Kola trees "and the cultivation of them is brought to great perfection by the "natives."

In passing, it will be noticed that in Mr. Elliot's report just quoted, the polycotyledonous nuts are only worth about half the price of those with only two cotyledons. As stated at the beginning of this paper, the species *C. nitida* is the one with two cotyledons, and *C. acuminata* is the species with the plural cotyledons. Thus, the statement that *C. nitida* is the species that supplies the best nuts is here confirmed. A further confirmation of this fact is found in the Report on the Agricultural Department for the year 1914, issued by the Government of the Gold Coast in which it is stated that:

"Only one European Company has given any attention to "this product (Cola) and their plantations are now in bearing. "No particulars are available of the past year's work, but it is "understood that a proportion of their crop is the *white* nut, which "fetches a relatively higher price than the ordinary Colas."

According to the nomenclature of the Cola trees, as given by MM. A. Chevalier and E. Perrot, the trees with all white nuts, and with only two cotyledons, belong to the species *Cola nitida* var. *alba*: this white Cola, then, must be regarded as the best one to propagate.

The great excellence of MM. Chevalier and Perrot's work is unfortunately marred by their pessimistic strictures on the future of Cola as a planting industry, strictures which would almost raise a doubt as to their opportunities of observing the Cola tree under fair conditions of growth, and which, at any rate, are without the least justification.

The authors would have us believe that the Cola tree is absolutely refractory to cultivation: that many of the trees only bear male flowers and never fruit, which is not at all unlikely where, as found by the authors, they grow under unfavourable conditions, either, in the midst of dense forest thickets, or at unsuitable altitudes of 800 metres above sea-level.

Again, we are told: "the fruit pods are far apart from each "other in the tree, and the harvesting must be slow and difficult." Now, the authors may never have thought how the Chinese or natives of this country bring down, with their long poles, bunches of coconuts from 80 to 90 feet up in the air, but it is hardly admissible that they should ignore the fact that the pods of the Cola nuts fall of themselves at maturity, and that the cost of harvesting need only be the cost of picking them up off the ground; for such is the case.

Lastly, we are informed: "Planters at San Thomé have "assured us that the most vigorous trees only yield a few kilos of "nuts in a year and that the crop was not worth the money spent "on it," and, if my memory serves me right, the maximum crop to be expected from a tree, would be some 10 kilos of nuts.

The reports given above from competent observers go some way towards dispelling such unfounded pessimism. But the following extract from the Report of the Government of the Gold Coast for 1914, should effectually dispose of the matter: on page 31, it is said:

"*Cola.*—The white cola trees are making fair progress.... "the 93 numbered trees produced 72,029 nuts. Four trees pro- "duced no fruit at all, and the highest individual yield was 5302 "nuts....one tree produced over 4,000 nuts—4 trees over 3,000— "6 trees over 2,000; and 7 trees over 1,000." These figures lead to conclusions very different from those expressed above and I shall not labour the question further.

But it is an understood thing that the introduction of a new crop in any country has to fight its way against detractors. It was the case of quinine at its first introduction in the East: it was the case of Liberian Coffee in the early eighties; and it was the same with Rubber of which it was said, in the early days, that it would not pay to tap before 8-10-12 years—that plantation rubber was unsuitable for making this and for making that: all cobwebs which time and fact have brushed away.

Possibilities of Cola.

It is probable that, at the present time, even allowing for a great increase of the demand from Europe for Cola, the introduction of its cultivation in a new country would not be without some risk, except on a limited scale. But it is not impossible to conceive in the future, a vast increase in the use of Cola, in these countries, should the natives acquire, as they do, almost to a man, in West Africa, and right away north, in Morocco, and Tripoli, a taste for the Cola nut, as a substitute for the betel-nut. We have in the Countries round us, millions of people who chew the betel-nut and we know how assiduously and how laboriously the practice is carried on, when a perfect quid is desired.

No doubt the areca-nut is not without its virtues: it is regarded by some, as a prophylactic against dysentery: like Cola, it provokes salivation and thereby allays thirst: it sweetens the breath, although it blackens the teeth: these are virtues enough to explain the use of the betel-nut throughout Eastern Countries. But it has none of the exhilarating and sustaining powers, against times of stress, which the Cola nut owes to its component alcaloids caffeine, theobromine and betaïn—to say nothing of the nourishment which its high starch-content affords.

Properties of Cola.

We have all heard of the property of Cola, of making palatable muddy or polluted water; of its well-nigh marvelous effects in allaying the cravings of hunger and of thirst, and enabling those who eat it to endure prolonged effort, physical or mental, without fatigue. The following extracts of a letter of the British Consul at Bahia, to the Marquis of Salisbury, then Foreign Secretary, puts these things in a graphic form:

Bahia, Sept. 6th, 1890.

My Lord,

"I have the honour to bring under your Lordship's notice.... "the great powers of endurance and strength in lifting heavy loads "and transporting them to long distances, in this tropical climate, "possessed by the West African negroes in these parts, which "personal observation.....enables me to attribute to the free use "of the Kola bean. The West African carriers at this port, who "use Kola, are not physically superior to the Brazilian negro, and "yet the African, through constantly masticating Kola, can endure "labour and fatigue which no Brazilian can withstand, and where "it takes 8 Brazilian negroes to carry a load with difficulty, 4 "African porters carry it cheerfully, almost always, even when "ascending a hill, singing and chanting the whole time, as they "trudge along, but never without a bit of Kola bean in their "mouths. The Brazilian spends in rum,....three times what the "African lays out daily in Kola nuts, which are not intoxicating— "not injurious in any way, act as a nutritive, quench thirst and "produce vigour and freshness.

"I have seen a bag of sugar of 80 Kilos (179 pounds English) "carried by an aged African negro, after biting a piece of Kola

"nut, and transported a distance of 4 miles, in an hour and a "quarer, without once taking it off his head."

Signed: GEORGE ALEX. STEVENS, *Consul.*

One would be inclined to believe that the philosophie's stone, or should I say the philosopher's nut, has at last been found, and some of the tribes of far inland African appear to think so, for it is said that the dry powder of the Cola nut is there sold for its weight in gold dust.

Any one wishing to form an idea of the physiological action of Cola on the nervous system, on the digestive organs, on the heart and on the muscular system, will read with profit the exhaustive study thereon by Doctor G. W. Barr (Therapeutic Gazette 1896) which is given at some length in Chevalier and Perrot's work.

CONCLUSIONS.

The conclusions which I would draw from the fore-going notes on Cola, are the following:

1st. Nine of the Cola trees growing in the Economic Gardens belong to the species *'Cola nitida,'* which is recognised as the best.

2nd. Although the crop just obtained is a small one, there is reason to hope for larger yields in the future.

3rd. Fresh nuts offer very great advantages, for making Cola extract, over dried nuts such as are perforce used in Europe.

4th. The Cola tree is not refractory to cultural treatment, and, under systematic cultivation, and fair conditions, yields of nuts can be looked forward to in a period of five years.

5th. For the present, the outlook of Cola cultivation in these countries, is limited, but native consumption might, conceivably, gradually create a very large demand: the spread of the use of the Cola nut through northern Mussulman countries tends to show that possibilities exist that way.

6th. Personal trials over a period of two months of the nut under various forms, have convinced the writer that the nut, as produced here, loses little, if at all, of the stimulating properties of the African product. As was shown in the body of this paper, its Caffeine content is as high as that of the African nut.

E. MATHIEU.

SOME CULTIVATED YAMS FROM AFRICA, AND ELSEWHERE.

The purpose of this note is to illustrate some unfamiliar cultivated Dioscoreas, namely:—

1. the white or eight months Guinea Yam.
2. the yellow or twelve months Guinea Yam,—*D. cayenensis,* Lamk.

White or eight-months Guinea Yam, Race No. 334 on the left of the half-metre and Race No. 340 on the right.

White or eight-months Yam, Race No. 336 above and Race No. 330 below.

3. a Hai-nan Yam, probably *D. belophylloides,* Prain and Burkill.

4. an African Yam, *D. dumetorum,* Pax.

5. an Indian Yam, *D. pentaphylla,* Linn., var, *Linnaei,* Prain and Burkill.

6. a Malayan Yam *D. pentaphylla,* Linn., var. *malaica,* Prain and Burkill.

7 and 8 Philippine Yams, *D. pentaphylla,* Linn., var. and an ally.

Dioscorea alata, Linn., which of all species is the yam most cultivated in Indo-Malaya, was the subject of an article in the last issue of the Bulletin. It is cultivated in Africa; but it is apparent that the Portuguese who used it for provisioning their ships on the return journey from India deliberately introduced it at their ports of call on the coast of that continent, not so much because they could not get yams in various parts of Africa, as because it was their wont to introduce everywhere everything, whether animal or vegetable, that might become useful. It is not intended to deal here with the races of *Dioscorea alata* now in Africa, but with other species only, and firstly with that Dioscorea which appears always to have had the greatest importance upon the Guinea coast and to be native. No botanical name will be given to it; but it will be called the White or Eight-mouths Guinea yam. Plate vi, illustrates it.

1. The White or Eight-months Guinea Yam.

This White or Eight-months Guinea yam has very many races in its own home. A glance at the plate shows that the tubers in some are more elongated than in others. Some, also, more abundantly than others have them protected by thorns on the roots: and again variation also appears in the foliage as the annexed outline drawings show. To enumerate the races is out of the question, and even to suggest a scheme for a classification of them is difficult. Therefore little will be said about their differences.

The tuber of this species has a skin of a dark khaki colour in all the races that have been grown, with white flesh under it; and if there is any sign in the cells of a substance with a magenta colour it is to be found only about the base of the stem at the top of the tuber. The surface of the tuber is generally rather free from rootlets and nearly smooth. The tubers may grow as twins or in small groups.

When the new stem appears above ground, it is thick and of a rather livid colour, with abundant prickles, and pairs of large broadly ovate bracts from the axils of which strictly at right angles stout rapidly tapering branches arise. It is obvious that these branches by their position and their rigidity, serve the purpose of preventing the stem from slipping back through the tangled thickets in which it would grow naturally.

Soon the bracts give place to paired leaves, and the stem becomes less prickly, until it is quite unarmed.

The leaves are of a medium or dark green, and do not spread themselves flat but the sides rise up, particularly towards the base, and the midrib takes a curve backwards. They are cordate-ovate when flattened in most of the races grown, but as the annexed outline drawings of the two flattened leaves show, may be elongated from this. The lower surface is paler than the upper. As all parts of the plant, they are quite glabrous. Usually they are about 10—12 cm. long by 6—7 cm. broad.

Leaves of the White Guinea Yam, one quarter natural size. That on the right the form which most races exhibit; that on the left an extreme leaf of the race Efura.

On the upper parts of the plant the side-branches show a tendency to droop from the horizontal, and to die abruptly so as to end with a pair of fully developed leaves. The petioles which are quite as long as the blades carry the leaves raised above the axis bearing them, and from the top of the petiole the blade is inclined downwards, facing towards the light, with the tip decurved towards the earth.

In the axils of the remoter leaves of the branches inflorescences arise. If male there are 1—4 spikes in each axil, attaining 4 cm. in length, and taking a forward direction from the axis which bears them. A spike about 4 cm. long may carry 24 flowers, spaced about their own diameter apart. These flowers take an angle of about 60° to the axis.

The male flowers have a rather broad base, but not so broad as in those Asiatic Dioscoreas where it presses the bract back against the axis: but the bract carries the bud like a bracket. The three sepals are greenish below, and yellow above; they broaden gradually through two thirds of their length, and then narrow quickly and obtusely. The petals are similar, just a little smaller and a little more obovate; they are slightly thicker. In anthesis the sepals part to half their length, and the petals at their tips, making a narrow way to the six introrse anthers which with their short filaments fill the whole of the interior of the flower. The filaments are half as long as the anthers. The flowers are very fragrant.

The female flowers are in spikes about 15 cm. long; the yellowish sepals and petals are broadly ovate. The capsules are

Yellow or twelve months Yam, Race No. 314 on the left of the half-metre measure, and Race No. 338 on the right.

A Yam of Hainan.

glaucous; their wings are broader than the half of a circle, so that the apex of the capsule is cordate: at the base the wing passes by a well marked angle into a wing on the stalk.

This species of *Dioscorea* was received in the Botanic Gardens, Singapore, from the Gold Coast and from Southern Nigeria in February and July, 1915, through the Royal Gardens, Kew. The first Singapore crops were dug in November, 1915 and February, 1916; the second in December, 1916 and the third in December, 1917. From the small beginnings of the first crop the stock has been built up sufficiently to justify a record of the returns got at the third crop. These were:—

Gardens' number and name of race.	number of hills.	average yield per hill.
330 Eyiberi { 1st bed	11	1358 grammes or about 3 lbs.
330 Eyiberi { 2nd bed	3	2079 ,, or about 4 lbs. 9 oz.
336 Iwayo o lorum	25	1966 ,, or about 4 lbs. 5 oz.
328 Esinrinmin	28	2228 ,, or about 4 lbs. 15 oz.
316 Puna	12	1047 ,, or about 2 lbs. 5 oz.
340 Oparaga	14	1723 ,, or about 3 lbs. 13 oz.
322 Odee krukupa	3	1861 ,, or about 4 lbs. 2 oz.
324 Batafu entumtu	8	2271 ,, or about 5 lbs. 4 oz.
334 Efura	18	3297 ,, or about 7 lbs. 4 oz.
310 Bayere pa	7	2571 ,, or about 5 lbs. 11 oz.
376 Eururuka apima	11	1477 ,, or about 3 lbs. 4 oz.

2. The Yellow or Twelve Months Guinea Yam.

The upper block of plate vii. represents a race of another species of *Dioscorea*—that which is second in importance upon the Guinea coast. It is believed that it is *Dioscorea cayenensis*, Lamk. Apparently the Portuguese early took it to the New World: and when it fell into the hands of the French botanist Lamarck, he in ignorance of its African origin named it from the colony whence his specimens came. It is a pity that it should have so obtained a misleading specific name. The identity of *D. cayenensis* with *D. prehensilis* which Bentham described when working at the collections made on the Niger Expedition, has recently been declared by French botanists (vide Chevalier et Perrot, Les Végétaux utiles de l'Afrique tropicale française, viii, Paris, 1913, p. 356 and Jumelle, Les cultures coloniales, Legumes et Fruits, Paris, 1913, p. 12).

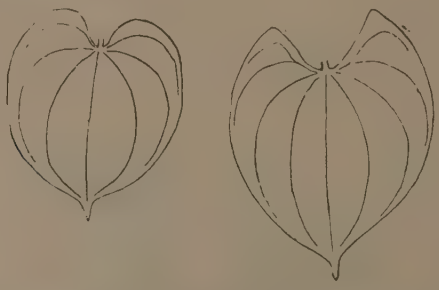
As the plate shows, the tubers of *D. cayenensis* are unlike those of the White Guinea yam in being more irregular and with a thick neck, and somewhat uneven surface. They differ also in being yellow fleshed.

The new shoots are thick and very prickly with dark reflexed prickles: they are of a purplish green, and carry alternate leaves at first, which may have thick branches in their axils in positions such as to prevent the stem from slipping back among the vegetation into which it is climbing.

The leaves are quite unlike those of the White Yam in their flatness in life and greater breadth. They are equally dark green,

and equally paler below. They are cordate-orbicular, and shortly acuminate, quite glabrous, as is the whole plant. The blade lies much more nearly in the plane of the petiole than does the blade in the White Guinea yam. Towards the upper parts of the branches flowers are produced. If male there are 1—4 spikes in the axil of each leaf. These spikes attain 6 cm. in length, and carry about 40 flowers spaced about their own diameter apart set on at an angle of about 70°, so that the angle which they take to the axis is a little larger than in the White Yam. They are sessile and though the base is broad, it is not so broad as to cause the bract to be reflexed. The buds are more stout than those of the White Guinea Yam, from base to apex more pear-shaped but laterally distinctly three lobed from the strong curvatures of the sepals. The sepals are white and they just part in flowering to one third of their length. The petals are brownish and shaped like the sepals, but smaller. Within are six introrse anthers on short filaments.

It appears exceeding probable that the White and the Yellow Yams have been confused in books, which should not be, as they are abundantly distinct.



Leaves of the Yellow Guinea Yam, one quarter natural size. That on the left is the common form; that on the right the form confined to the bases of the stems.

3. A. Hai-nan Yam apparently Dioscorea belophylloides.

The lower block of Plate vii shows the tubers and leaves of a species of Dioscorea which was introduced into Singapore from the Chinese province of Hai-nan by a servant of Mr. G. P. Owen; and Mr. Owen presented tubers to the Gardens. The return that they give is small; and they are uneven so that if peeled for cooking a large part of them is lost; but they are excellent cooked.

This yam has not as yet flowered in Singapore, and there is some doubt as to its name; but it appears to be *Dioscorea belophylloides,* Prain and Burkill.

4. Dioscorea dumetorum.

The top block of plate viii illustrates *Dioscorea dumetorum,* Pax, an African ally of the Indo-Malayan *D. hirsuta* (D. triphylla,

Linn. in part or D. daemona, *Roxb.*). Just as *D. hirsuta* is a most important famine food of India and Malaya, so does *D. dumetorum* appear to be a famine food in Africa; but it appears to be more, for whereas *D. hirsuta* has given no cultivated races, *D. dumetorum* has: and the conflicting statements of travellers as to its utility are to be explained in the light of this.

Two very distinct races are in cultivation in Singapore: in the one the tubers are lobed; in the other the tubers are star-shaped. The plate shows both. The bluntly lobed tubers were from a stock received as Nfamko from the Gold Coast; while the star-shaped tubers from one called Esura in Southern Nigeria. With the original tubers of Nfamko was received a memorandum stating that Nfamko is edible but medicinal. Esura has been eaten in Singapore without causing any discomfort, but it is slightly bitter.

Bearing the name of Esura there are again two races distinguished by their colour, the flesh in one being white and the flesh in the other being yellow. That this should be so is most interesting because *D. hispida* exhibits the same variation in colour being sometimes yellow and sometimes white, but as regards it as yet the colour has not been shown to be a racial characteristic.

When *D. dumetorum* sprouts, it throws up a stout prickly shoot, with alternate leaves; and these leaves have the peculiarity that the base of the petiole is bent downwards sharply in such a way as to aid the plant in climbing by preventing the stem from slipping back over its support. It is most interesting to find in *D. dumetorum* as well as the White and the Yellow Guinea Yams—species all of the same region—the need of holding to its support met in a slightly different way.

The leaves of *D. dumetorum* are compound: at the apex of a prickly petiole are three leaflets, which when young are sparingly hispid above, then glabrescent, but on the back at all times densely shortly hispid-pubescent. The middle leaflet is obovate, and usually very long acuminate; the lateral leaflets are of the same shape in the inner half, but as regards the outer are cordate, and often with a lateral lobe. Towards the apices of the stems the middle leaflet is often smaller than the lateral leaflets.

Inflorescences arise in the leaf axils towards the ends of the stems. If male a pyramid of spikes is produced, which may be up to 10 cm. long: the axes and the bracts are densely stiffly pubescent, and the thin glabrous orbicular-ovate sepals peep out from among the hairy bracts. These sepals exposing the green ovate petals open at flowering rather more widely than do those of the flowers of the White or the Yellow Guinea Yam a movement facilitated by thinness: they are ovate and rounded above. The petals are only a very little smaller than the sepals: and there are six introrse stamens within.

The female spike may attain as much as 70 cm. when the fruit is ripening; it carries some 30—40 flowers. The fruits are elongated and very like those of *D. hispida.*

Dioscorea pentaphylla and an Allied plant.

The lower block of plate viii illustrates some Indo-Malayan Dioscoreas of the same section as *D. dumetorum*. First of all there is *Dioscorea pentaphylla,* Linn., var., *Linnaei*, an edible variety of that usually inedible species, cultivated in Southern India and Ceylon. It is the *D. pentaphylla* which Linnaeus had from Ceylon in his Herbarium,—a variety which probably was more commonly cultivated there in his time than now. Cooked properly it is a very good vegetable, but as the figures show it buries so deeply that the labour of digging it up is considerable, and the return is small. It is likely therefore for all time to remain rather a curiosity than a commodity.

The stems and the leaves in this variety are much smaller than those of most of the varieties of *D. pentaphylla,* and it is almost deserving of specific rank. The leaves are relatively small and the stem is wiry, prickly and purple-flecked.

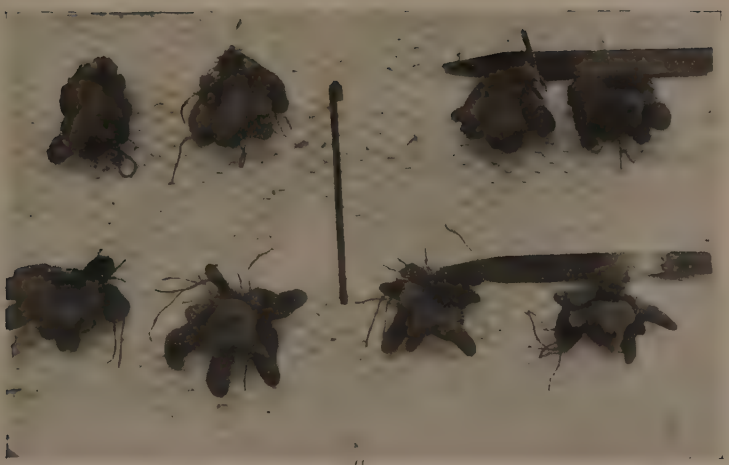
In Singapore, it flowers 6—8 months after the shoot has appeared above ground, and later considerably than the varieties of *D. pentaphylla* from Northern India that have been grown experimentally alongside it.

The four tubers at the top on the right of the same block represent *Dioscorea pentaphylla,* Linn., var., *malaica*. The parent tuber came from a garden hedge in Penang where it was but small; but in the Botanic Gardens, Singapore, tubers weighing up to 9638 grammes or 21¼ lbs. have been raised. The variety may be found here and there through the Malay Peninsula, and usually in garden fences.

The four tubers on the lower row to the right represent two Philippine stocks. They are numbered 196 and 198. No. 196 furnished figure 5 on p. 207 of volume iii of the *Philippine Agriculturist and Forester;* and No. 198 furnished figure 6. The first is certainly ascribable to *Dioscorea pentaphylla,* Linn. Its big clavate tubers have very soft flesh, and keep very badly. It flowers regularly.

But No. 198 refuses to flower. However the stems and leaves exactly match Philippine herbarium specimens which bear the number "Ahearn's collector 1971" from Rizal and these have female flowers; but the female flowers are not altogether adequate to place it and fruits must be sought. It also matches exactly the sterile specimens of Ramos 12176 to which the note is attached "tuber edible." The tubers are most abundantly lobed and with soft white flesh. As it grows in the Botanic Gardens, Singapore, it dies down in 6—7 months, *i.e.* as *D. pentaphylla* var. *Linnaei* is coming into flower. It produces an abundance of bulbils about 1—2 cm. long with a rough brown skin like shagreen.

I. H. Burkill.



Dioscorea dumetorum, Race No. 382 above and Race No 346 below.

On the left of the half-metre measure two tubers of Dioscorea pentaphylla, var., Linnaei, origin Ceylon: on the right above, four tubers of Dioscorea pentaphylla, Var., malaica, origin Penang: on the right below, tubers of two Dioscorea allied to D. pentaphylla, Nos. 196 and 198 origin Luzon.

THE SECOND PHASE IN THE HISTORY OF THE BOTANIC GARDENS, SINGAPORE.

The history of the Botanic Gardens from their foundation in 1859 to the year 1874 was given in the last number of this Bulletin. Up to 1874 the Gardens had been the property of the Singapore Agri-Horticultural Society, which becoming unable to maintain them any more in a fitting condition sought the Colonial Government in that year with a request that their property and their debts upon it should be taken over, and the Gardens maintained out of public funds. To this the Government of the Settlements agreed, placing the Raffles Library and Museum Committee in charge until such time as the legislation which the case required could be passed. The legislation was passed in 1878 as the "Raffles Societies Ordinance, 1878"; and upon January 1st, 1879 a Committee consisting of the Colonial Secretary, the Colonial Engineer, and one unofficial member (Mr. R. Campbell, who had been the last Secretary of the Agri-Horticultural Society) assumed charge of the Gardens for the Government.

But for the four years from January 1st, 1875, to the end of 1878 the Gardens had already been carried on by means of Government funds, and the Government had authorised the Raffles Library and Museum Committee to apply to the Director of the Royal Botanic Gardens, Kew, for a Superintendent. To them Sir Joseph Hooker had sent out a very young man, Henry James Murton, son, it seems, of a Cornish nurseryman; and he had arrived in Singapore in October, 1875. He had halted in Ceylon on the way to visit the splendid Gardens there, and make his first acquaintance with tropical conditions: and he arrived with liberal donations of plants from thence.

He was too young to be over Niven, who had been the Society's Superintendent and now had the title of Manager, yet had to be by the terms of his appointment: this difficulty however was solved by Niven taking leave; and while on leave he unfortunately died. Murton carried on alone for a short time when Niven had gone, until a Head Gardener was appointed from England, named George Smith. Smith arrived in the early part of 1877; but died suddenly in April, 1878. Next in succession, in June, 1879, Walter Fox arrived from England, having been appointed by the Secretary of State to be Murton's second. For the care of the animals of the Zoo Murton had had the help of one, H. Capel, but only from some date in 1876 into 1877.

The buildings in the Gardens when Murton came were, (i) the house that he occupied which is now the Director's, (ii) an orchid house, (iii) a shed with birds in it, and (iv) cooly lines.

The roads were more numerous than now and narrower. They were not well surfaced, and their edges were limited by earth drains: but as many of the visitors were horsemen out for exercise, and visitors of this class had been more in preponderance when the gates were open only to subscribers, a soft road was in some degree suitable. The Main Gate Road was embanked along the

Lake side, the lawn being hollow upon the east of it. Trees were plentiful, especially fruit-trees of the commoner species. The flowering bushes were extensively cut over in order to meet the demand for bouquets to which the subscribers had a right. There was a croquet lawn on the side of the Bandstand Hill; and near by the Gardens Jungle approached the Bandstand a little more closely than now. Bands played regularly, and visitors took advantage of them for a promenade. The property which the Agri-Horticultural Society had bought in 1866 was undeveloped.

Murton entered upon his duties with great energy. Directed by a Gardens Sub-Committee of the Raffles Library and Museum Committee, he corresponded with all the Agri-Horticultural Societies and Botanic Gardens in the East from Hongkong and Brisbane to Mauritius, obtaining exchanges; he corresponded with Kew, and received many plants thence. In exchange he sent out plants of local origin, chiefly orchids. His new introductions he planted all over the Gardens, until in 1878 and 1879 we find him complaining of the lack of space for more. His work was much dominated by the rapid growth of the Zoo, the developed parts of the Gardens becoming dotted with enclosures for animals. He commenced an economic garden upon the undeveloped property, and planted extensive beds for cut flowers near to it.

Unfortunately he was unstable and careless. That which interested him he did; that which did not, he was ready to neglect; and therefore the Gardens Sub-Committee kept a tight hold on him, which the Government Committee tightened. This he resented. He grew absorbed in the Botany of the island, and compiled a manuscript flora, neglecting the Gardens for time to work on it, and neglecting his accounts which were found in confusion, and which he would not attempt to put right. Then followed in 1880 his dismissal. In 1881 he died in Bangkok, his death perhaps hastened by his having burned the candle at both ends.

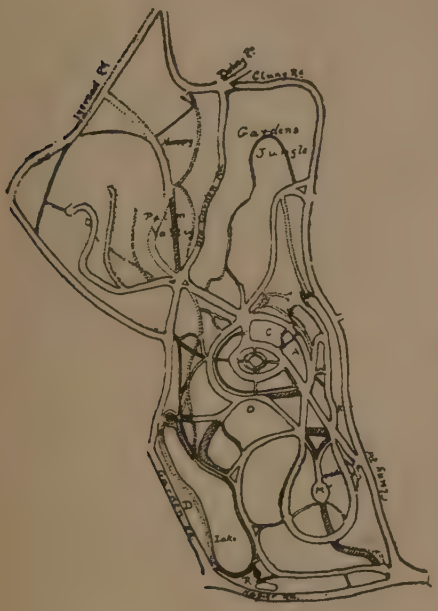
His qualifications had been good. Within five months of his arrival he had determined the cultivated plants in the Gardens, and made a list of them. He had bought from Collins when Collins was dismissed from the Museum, a collection of dried plants, mostly picked out of well-known herbaria and he appears to have increased it by his own collecting; he pressed the Government to buy it, and it appears that they did ultimately, but it had suffered considerably before Mr. Ridley first saw it.* In 1877 he travelled much, first visiting Kedah for plants, then Gunong Pulai in Johore (June), and later, that he might study the sources of Gutta percha at the suggestion of Sir Joseph Hooker, he made under Sir Hugh Low's direction a long journey in Perak, visiting the Taiping Hills, Gunong Bubo and the neighbourhood of Kampar. A full account of this journey was printed in the Government Gazette 1878, pp. 101-110. No later journeys are recorded.

His influence upon the Gardens can hardly be described without first giving some account of the Zoo, as its growth and rapid

* Vide Ridley in the Gardens Report for 1889, p.7.

removal rather adversely operated against him. This is an account of it.

Immediately it was generally known that the Government would maintain a collection of animals in the Gardens gifts poured in. Sir Andrew Clarke presented a Two-horned Rhinoceros, Sir Ernest Birch a Sloth Bear, Messrs. Brinkmann and R. Jamie each a Sambhur Deer, Captain Kirk two Orang-utans, the Acclimatisation Society in Melbourne an Emu, one Great Kangaroo, three Red Kangaroos and a Bush tailed Wallaby,—all in 1875; and in 1876, the King of Siam a Leopard, Mr. Hargreaves a Leopard,



Plan of the Botanic Garden showing the old and new roads. All roads made since Niven went are dotted: all roads closed since he went are cross shaded. R, is where the Rhinoceros' enclosure was: D, the deer enclosure: M, the Monkey House: K, the Kangaroo and Emu pens: A, the old Aviary: C, the first Carnivora house: O, Murton's Office.

the Sultan of Tringganu a Tiger. These were in addition large numbers of gifts a smaller animals. All the large animals needed expensive arrangements for accommodation. For the Rhinoceros an enclosure with a house and a wallow were made near Napier Road by the foot of the lake. For the Deer an enclosure was prepared against Garden Road: for the Kangaroos and the Emu paddocks were fenced adjoining Cluny Road near the Office Gate; the Carnivora were given a house at the north east side of the Bandstand hill where the Agri-Horticultural Society had had an Orchid House. The aviary was erected on the east side of the hill. At the expense of a Chinese merchant of Singapore, Mr. Cheang Hong Lim, an ornamental iron structure was put up as a Monkey House (completed April, 1877) near where the Herbarium now is, to become the centre of the Zoo after Murton had gone.

The expenditure of building all except the Monkey house fell upon the Government grant and was too much for it so that Mr. Kröhn in the Annual Report for 1875 wrote "the money allowed although quite sufficient for the upkeep of a Zoological Garden of fair dimensions, is quite inadequate for the erection of suitable houses for the various animals."

At first two privates of a regiment stationed in Singapore were employed as keepers; then in 1876 Mr. Capel, for whom a small house was built below the Aviary. But Mr. Capel's pay, small as it was, made a large hole in the grant, and in 1877 he asked for a rise, which led to a decision no longer to retain him; Chinese next and then Javanese were resorted to as keepers, the system of using Javanese lasting until the end of the Zoo.

There were big losses among the animals; for instance in 1876 some evil-disposed person or persons killed a Bear, the Emu and a Cassowary in one night; the Rhino* died in 1877 and two Kangaroos, and in 1878 both of the leopards. Losses so large caused the Committee to take the important decision of limiting the collection to small animals†; and they sent the Tiger and Orang-utan and a number of other animals to Calcutta, as exchanges for Indian birds (Report 1879, p. 6). The year 1878, thus, saw the

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* The skeletons of the Rhino, and some other animals are in the Raffles Museum.

† The following footnote is from a MS list of the animals in the Zoo on 27th September, 1877, which shows how large the Zoo was. The Rhinoceros had just died.—

1	Tiger	1	Héron
2	Leopards	3	Manchurian Cranes
2	Dingo Dogs	2	Pelicans
1	Jackal	3	Black Swans
1	Binturong	1	White Swan
1	Sun Bear	2	Water Rails
1	Fish Tiger	30—40	Teal and Mandarin Ducks
1	Civet Cat	2	Wood Pigeons
2	Common Carys	2	Nicobar Pigeons
1	Rabbit	1	Green Pigeon
1	White Rat	3	Ring Doves
1	Flying Fox	3	Common Doves
1	Kangaroo	2	Parrakets
2	Red Deer (Bucks)	1	Blood Brested Pigeon
3	do. (Does)	2	Horned Owls
3	Sambur Deer (Does)	1	Sonnerat's Jungle Cock
1	Sambur Deer (Buck)	1	Large Parraket
2	Opossums	2	Crested Peacock Pheasants
1	Kawoo	2	Fireback Pheasants (Cock and Hen)
1	Orang Outan	1	Pheasant (Cock)
2	Wou-Wous	2	Rufus tailed Pheasants
2	Black Monkeys	1	Golden Pheasant
1	Spider Monkey	4	Ring Neck Pheasants
1	Bear Macaque	4	Guinea Fowls
1	Red face Macaque	2	White Eagles
4	Porcupines	1	Falcon
1	Cassowary	4	Hawks
5	Pigtail Macaque	3	Sparrow Hawks
1	Emu	4	Crowned Goura Pigeons
3	Peacocks	1	pair Argus Pheasants
1	Manila Duck		

end of the ambitious Zoo§ commenced in 1875. Deer were retained, as inexpensive to feed; and when in 1877 the fence of the first enclosure across the lake became rotten (it must have been a wooden structure) they were accommodated in the now empty Kangaroo enclosure temporarily: but it in its turn began to go to pieces in 1878 (Report p. 6): and in 1879 their old enclosure was repaired with a strained wire fence, and within it they remained until much later giving at times a lot of trouble by breaking bounds. Meanwhile the other enclosure for the large animals were swept away more quickly than they had been erected.

The uncontrolled growth of the Zoo, must have made a great difference to the Gardens; and it was well that as it had to go, it went so quickly: by 1879 equilibrium had been reached again. The short stay of the Tigers had caused the old orchid house to be removed and some terracing on a small scale to be done; the short stay of the Rhino had caused some levelling to be carried out, and ultimately its wallow became a Water lily pond: the erection of a house for the Keeper Capel left the Gardens in possession of a building which was afterwards useful for a number of years, as a gardener's house, and then under Cantley for his clerk.

We will take the year 1879 as a convenient one, for a description of the Gardens under Murton. They were then in their twentieth year: Murton had done his best planting; and the Zoo had become stable.

The visitor in 1879, approaching the Gardens from town, found at the entrance what Cantley afterwards called "heavy masses of masonry doing duty as pillars." Passing between them, he would have found two roads—neat roads newly bordered by brick drains* one road leading straight forward, the other ascending to his right, and bordered by a particularly large drain. This road on the right soon after was closed and a pathway laid instead along its line; but in 1879 the visitor who followed it was conducted to the Herbarium Ring Road, and could cross it and proceed first on a path, then on a road, nearly straight to the southern face of the Bandstand hill, and on his way he would have passed the new Monkey house noting there that the roadway had been recently altered.

The other road, leading straight forward from the main gate is that which persists; at a little distance it was joined by a small path, by which anyone approaching from the Barracks could enter the Gardens through a turnstile upon a small bridge. A little further than this small path, the road reached the foot of the Lake and then followed its margin to another fork, the right arm of which now persists as the Main Gate Road, and the left

§ To limit the Zoo to smaller animals was the first decision: to limit it to Malayan animals was a later decision. For an account of the animals in the Zoo when it was Malayan, vide Ridley in the Journal of the Straits Branch of the Royal Asiatic Society, No. 46, 1906, pp. 133-194.

*Murton had been allowed to dig laterite from Goodwood Hill for these roads until the supply of good material there had been exhausted. Turf for the Lawns he was allowed to draw from Fort Canning and Magazine Hills.

as a footpath. The road on the left in 1879 completed a loop with the other of the roads from the Main Gate, while that on the right—the persisting road—led straight towards the Office Gate and on the top of the hill joined the Bandstand-Herbarium Ring system of roads. On the Main-Gate Road near the Gate Niven had had raised beds which obscured the unevenness of the ground; these raised beds had been removed, and a certain amount of smoothing had been done by Murton,—not as much as was subsequently done, but something—which still left the lawn too low on the left. From that lawn, Murton had newly removed large trees and a row of Betel palms which lined the boundary stream: clumps of Sago palms he had allowed to remain, as they persist still: in front of them he had planted many of his new introductions, and where the Betel palms were he had planted a row of palms of the genera *Stevensonia* and *Kentia*. Past the second clump of Sago palms Niven had had two small ponds which Murton had dug into one, at the end of which, had the Zoo grown as its promoters hoped, Alligators were to live; the near half of the pond was occupied by Waterlilies including *Victoria regia*, and the further half by the Lotus lily. Just beyond this pond had been the Rhinoceros enclosure with its wallow. Much levelling had been done to accommodate this animal which lived for such a short time in captivity, and had left the place improved; while the wallow, at first closed up, was later converted into a small pond.

From the Main Gate to this point upon the north of the Road the visitor in 1879 would have found the hill side dotted over with disappointingly young plants, being Murton's new introductions planted in some order, Conifers near the Gate, Cycads near the turn by the foot of the Lake. The trees of *Casuarina sumatrana*, now so effective, were then three years old, and could not have been effective then.

The visitor on arriving at the foot of the Lake found himself in front of the strained wire fence by which the Deer, whose enclosure was between the Lake and Garden Road, were ineffectively prevented from getting loose and doing damage in the rest of the Gardens. No path existed at that time west of the Lake.

The islet in the Lake was occupied chiefly by a large *Ficus*.

Following the Lake side the visitor might have noticed that the Lawn on the right had been newly raised to the level of the road, so as to do away with the old embankment; this Lawn is sometimes called in the older papers the "main Lawn," and by that it may be judged that it was more open than now.

If the visitor had kept beyond the fork of this road to the left, following the Lake side, he would have been led to two small rather unfinished terraces§ upon the side of the Bandstand Hill where Murton had his office and an orchid house, as well as lines for coolies.

The Orchid house was occupied in 1879 by miscellaneous plants, largely annuals, for the orchids had been placed on trees

§ Cantley smoothed them in 1882.

about the Gardens. Beds of annuals were upon the terraces early in 1879; but this form of bedding was stopped during the year on account of the expense.

The Office had big eaves, alike for affording a shelter against rain to visitors, as for ripening off plants of periodic growth. It was damp, and Murton kept no books in it. The orchid house was low and covered with creepers. The neighbourhood had been opened out considerably by removing old trees.

The visitor having reached the office could take the Lower Ring Road in either direction, or ascend the steps to Niven's lower terrace, and so reach the Bandstand, or if he cared he could proceed towards the Main Gate again down an avenue of palms between flower beds to the Monkey House, round which new planting had occurred in order to give shelter to the Monkeys, and where, as said, the road would have been found broken. This break was with the intention of preventing carriages from reaching the Monkey House, pedestrians instead being encouraged by means of four new paths one made out of the old roadway each blocked against carriages by a stone pillar.*

If the visitor had entered the Gardens by the Office Gate, he would have found leading to the left the line of a closed-up road with a row of Araucarias on its south side. Three of these Araucarias still stand. The road had been the end of the Main-Gate Road, unintentionally so constructed as to lead strangers who had entered at the Main Gate out of the Gardens at the Office Gate. Such an arrangement, not unsuitable when the visitors were the subscribers to and owners of the Gardens, and therefore familiar with the turns of the roads, was unsuitable when the Gardens were becoming a resort for anyone and everyone: and the Sub-Committee ordered the closing of the end of the road. The road to the right was that which still persists—being apparently the first road made in the Garden of the Agri-Horticultural Society. Ascending it the visitor passed the end of the Herbarium Ring Road and then had on his left Murton's new palm plantation. On his right were more Araucarias in a row along the side of Cluny Road as far as the old Kangaroo enclosure, and a path led near them and gave a branch up hill to the Aviaries upon Niven's lower terrace.

The visitor would have found the roads about the Bandstand much as they are now. They had been narrower and the Upper Ring Road had been limited by a circular border which Murton had removed, as being an obstruction upon Band evenings; and he had thereafter been able to throw an extra eight feet into the road. He had also done away with many beds upon the upper terrace and substituted Crotons in tubs. The lower terrace was bedded with shrubs. The Aviary was upon it to the east of the Hill; and to the north-east, to which Niven's terracing had not extended, but where

* Two of these stone pillars are still in situ.

the Agri-Horticultural Society had had an orchid house, surrounded by trees, Murton had cleared considerably, and had made small terraces on one of which the Carnivora House had been placed. At its back trees had stood, which up to 1877 were heavily festoned with the beautiful indigenous climber *Thunbergia laurifolia*. Unfortunately it kills its supports; and no sooner had Murton commenced to construct a fernery under the shade of the creeper, than the trees began to fall; he wrestled with the situation by scaffolding, but this perished; and in 1879 there was little but an untidy corner, where the fernery had been commenced. Moreover Murton complained bitterly of the way in which his best ferns were stolen from this place. The Carnivora cages had been removed before 1879; and in their place Murton had planted a collection of Bromeliads. Behind them, across the Lower Ring Road and screening off the Propagating yard, was a tongue of virgin jungle, which is now cultivated for shade plants, and contains Shoreas with other typical forest trees: however the tongue has been lengthened slightly by newer planting.

West of the Bandstand hill the paths were not at all as they are now. Flower-beds were about the head of the Lake; and no screen of trees such as is now, but a plantation of Pomelo trees and trees of the Kenari nut, with behind them cooly lines, and a shrubbery near the Tyersall Gate.

Along the Maranta Avenue was a long border with shrubs. Garden road had not ceased to be a public thoroughfare; and the Palm valley was untidy. Its slope under Garden Road had served Murton for a source of clay when he needed it, and so been bared; then he had smoothed it somewhat and tried to get it grassed over: toward Cluny Road it was covered with *Gleichenia* fern. An old cart track leading into the valley he had filled; and from the top, where he seems to have planted palms, a path was made down to the hollow which he had developed as an Economic Garden. In this Economic Garden in 1879 the visitor would have found patches of coffee,—Arabian, Liberian and Cape Coast,—the latter two being introductions of 1877; the first as elsewhere in the Peninsula was suffering from the attacks of *Hemileia*. He would have found Tea, Cacao and Sugar-Cane. The Canes were good introductions from overseas, and were much pilfered. He would have found Ipecacuanha struggling, and Cardamoms, Avocado Pear, and all the various rubber trees that Kew could send out, including *Hevea*, as well as 4000 pots of the local Gutta Singarip (*Willughbeia firma*) which it was thought had a future, and 2000 pots of Eucalypts. He would have found also Teosinté, Maize, Mahogany and various fruit trees.

There was a raised path limiting the Garden on the north and beyond it swamp forest. If the visitor had followed the path westwards he would have found large beds for flowering shrubs which Murton raised with the purpose of saving the flowers in the more public parts of the Garden from being cut for bouquets.

Murton had for the Garden in the year 1879 from Government $7,580, and by subscriptions and sales a further $370. Out

of it he was able to spend over $3,000 on coolies' labour, so that as the wage was $5 per mensem (and had been $4), he had fifty men in employment besides his overseers, and that is more than the Department has been able to retain in the "Botanic Garden" for very many years up to the present year.

In the year 1879 the Government authorised the Gardens to commence planting a piece of land called the Military Reserve which lies to the north. This land is what is now known as the "Economic Garden." The first occupation of it began at once and a shed for Chinese coolies was erected, and a house for the Road foreman employed in the Gardens.

This Military Reserve was not altogether waste when taken over; its lower parts had been planted in indigo by Chinese, who lived on the slope among fruit trees. The low land seemed to Fox who happened to have been at Kew when Cross had returned from Para with his first Rubber seeds, to be just the kind of ground which Cross described as suited, and he took the young Hevea trees in the Palm valley to it. He set to work also planting on the higher ground, but single handed after Murton's fall could do little,

Murton's last work for the Gardens was the compilation of a Gardens' catalogue which was printed and published; but is not available in the Settlements, because Cantley suppressed it as altogether unreliable (Report for 1882, p. 13).

Nathaniel Cantley, a native of Thurso, N.B., Kew-trained and for a time Assistant Superintendent of the Botanic Gardens in Mauritius, was now appointed to succeed Murton. He arrived in the Colony in November, 1880, but was forced by illness to take leave in March, 1881. Again Mr. Fox acted while Cantley voyaged to England via the Cape. Sick as Cantley was when he went on board, he had some two thousand botanic specimens cut from the trees in the Gardens and their neighbourhood which he dried on the voyage with a view to getting them determined at Kew. It appears that many of these found their resting place in the Kew Herbarium. Cantley resumed charge at the end of 1881, and presented a programme of work to the Gardens Committee which obtained approval. First of all be it said that the Government had the formation of a Forest Department in mind, and with that in view Cantley proposed that the Military Reserve should carry a series of Malayan timber trees. This was approved; and because the space in the Botanic Garden for new introductions was, as Murton complained, restricted, Cantley wove into his series of Malayan trees, all those of his new introductions which had an economic value, until gradually the importations exceeded in number his Malayan trees. At the same time into the Botanic Garden he planted the things that had not an economic interest. Next he made, with approval, two nurseries, one for ornamental plants in the Botanic Garden, and one for forest trees in the Military Reserve. The second covered several acres adjoining Cluny Road and extending back a couple of hundred yards to where traces of it exist still in groups of certain trees. He arranged for the sale of plants from these Nurseries. Thirdly he asked for, and got, a

suitable office building wherein he could house a Herbarium and a library. Then he named the staff required, and the alterations necessary in the Gardens to bring things into order, including the adequate labelling* of the collections over which Murton had complained of considerable difficulty, and for the effective policing of the grounds by day and by night.

Cantley was a great advocate of order. The arboretum he planted in botanical sequence on the system of Bentham and Hooker with one end at the Cluny Road entrance to the Economic Garden and carrying the series eastwards. He had made in 1882-85 from near the foot of the Lake to the Tyersall Gate a series of flower beds‡ whereby the visitor was introduced to this system in ornamental plants; but the impossibility of filling the beds with plants suited to the climate broke his scheme down. Thirdly when Murton's palm collection wanted replanting, he proposed to arrange it according to the "Genera Plantarum." What Cantley meant in 1882 by saying that the Singapore Gardens had never been a "Botanical Garden," was that this botanical orderliness which so appealed to him was not present, nor the plants labelled. He had extensive flower beds on the Lower terrace of the Bandstand Hill, which held no less than 20,000 plants; and in 1886 made more at the Main Gate. In administration this love of order did much for the Gardens; for instance, Murton had left cooly lines in three places, and Mr. Fox had complained that numbers of men were continually walking about at night who when questioned always had the excuse that they were proceeding from the one set of lines to see their friends in another, and that this conduced to thefts: Cantley concentrated the coolies in his new propagating yard partly in new buildings, and partly in buildings left by Murton. Capel's house because the clerk's house. To a place near to the Propagating yard he took the Plant Houses; and to a place near enough also and furthermore conveniently reached by visitors he took the Gardens office. Putting forward the need of a building in which Flower shows could be held he induced the Government to build in 1882 between the office and the Propagating yard the Large Plant House; and it has been used again and again for that purpose, the collection of pot plants within it being removed temporarily.

The Zoo he concentrated in 1885 at the Monkey House, erecting new aviaries like brackets on either side of it: and encircling these again for shelter with trees and shrubs.

Thus Cantley cleared the Bandstand Hill of all buildings; for the office was no longer wanted, nor the little very unsuitable orchid house, nor the cooly lines; and a Rosary was made where they had been: the Aviary also disappeared from the lower terrace. The Rosary beds were just as the beds containing Cannas are now,

*Murton's labels had been painted by convicts in the jail

‡There is preserved in the Public Works Office a ground plan with levels showing the Main Lawn covered with flower beds and the curves of the paths to the old Monkey House altered. This plan, which is undated, appears to have been connected with Cantley's desire to maintain a collection of bedded plants illustrating Systematic Botany.

but instead of grass had walks between them. Upon the top of the Hill he planted in 1882 Araucarias and Crotons, and placed ornamental vases and garden seats. At the head of the Lake he launched an undertaking which failed. He removed the flower beds; and a big cistern having been made in 1886, he threw up mounds which were to be irrigated and to support delicate ferns. While this was being done, he altered the footpaths on that side of the hill so as to conduct visitors to the fernery, and he planted trees round the cistern to hide it.

North-east of the Bandstand hill close to where Murton's fernery had fallen, he made another fernery. Here he had forest overhead, and by thinning it, and throwing the surface into mounds into which stone was inserted, he obtained a very suitable place. Funds did not enable him to finish it rapidly and what was started in 1883 was not completed for a long time.

The shrubberies all along the border of Cluny Road to the Large Plant House he first made. New gate posts were erected at the Main Gate in 1885 and topped with globes in 1886. By the kindness of Messrs. Gilfillan, Wood & Co. he was allowed to place a hand pump across the Cluny Road and pump water to the Plant Houses from the head of the little stream that runs there. He did not follow up Murton's scheme of raising flowers for bouquets at the west of the old Economic Garden, but laid out what we now call Lawn R in stiff rectangular beds for the purpose. In the Economic Garden in 1883 he experimented with European vegetables.

Cantley's staff for working the Gardens consisted of himself, Walter Fox, a clerk, a foreman gardener and a propagator, both the latter two selected as being able to read and write, a label-printer a mason and a carpenter. Three constables were quartered in the Gardens each taking a day and a night beat in turn just as the watchmen do now. In the first three years of his service in the Colony the Government grant was $10,000 which was expected to cover all expenses, with the help of $750 to $850 from subscriptions and sale of plants. In 1886 the pays of Cantley and Fox were excluded, and the Government vote put at $7,000. The forest vote maintained the planting upon the Military Reserve.

Cantley, as time went on, became more and more tied by his Forest work. Then at the end of 1887 his health again broke down and he went to Australia on leave where he died. Mr. H. N. Ridley succeeded him in the next year. But before Mr. Ridley had arrived in the Colony a little "Guide to the Botanic Gardens, 1889," had been prepared by Mr. Fox and was in the press. As it gives an account of the condition of the Garden at the age of thirty years, the reader is referred to it. All which here follows will be but a statement of subsequent changes taken seriatim in order that it may be clear what of that on which the eye of the visitor of 1918 rests, was absent in 1889.

Mr. Ridley's service marks the third period in the history of the Gardens; and it will not be reviewed. The four outstand-

ing results of it are: firstly, the excellent Herbarium of the Higher plants and ferns of the Malay Peninsula, whereby he is now enabled to write a Flora of the Peninsula; secondly, the considerable planting of Rubber, whereby as the Peninsula enormously benefitted, so too the Gardens obtained a large income enabling them to be maintained without an increase of the Government's vote although the relative value of the vote was much reduced with the fall of the dollar; thirdly, the housing of the Gardens' staff upon the Military Reserve ground; and fourthly, the commencement of publication of results. He was in charge of Forests up to 1901; but from 1892 the Military Reserve or Economic Garden ceased to be maintained out of a Forest vote.

It is not given to everyone so admirably to round off his service as Mr. Ridley is doing: he will finish his Phanerogamic Flora of the Peninsula in retirement. Meanwhile the Gardens have entered upon their fourth period, with two outstanding objects (1) to extend the study of the Botany of the Peninsula to the Lower Plants, and (2) on the horticultural side to widen the efforts in acclimatisation by the use of all those opportunities which selection and plant-breeding afford. For both purposes officers have been appointed, but the War has delayed the start.

APPENDIX.

Changes subsequent to Cantley's death which have made differences in the appearance of the Gardens.

There is nothing which throws greater difficulties into an understanding of the Annual Reports of the Gardens than their inconsistences in the names of buildings and roads. The same plant house, for instance, is in one year the "Shade-plant house" and in another the "Aroid house": and what is true of the plant houses is still more true of the roads. In 1913 names were given to the important roads, that they might be cited in Police regulations, and they were labelled: since when the whole of the Gardens has been divided into areas which, in the Botanic Garden, are denoted by letters, and, in the Economic Garden, by numbers. In the Botanic Garden the letters denoting each area appear upon the labels to the trees. The accompanying map records them; and the reader may find it a guide to him in running through the following list of the more noticeable changes made since Cantley's death.

Changes near the Main Gate.

A brick boundary wall with iron railings was erected from the Main Gate to the Office Gate, 1904.

Cannas, first introduced into the Gardens for bedding in 1894, have been made of great use near the Main Gate since 1914.

The little path towards the Barracks across Lawn A. was closed in 1912.

Small paths round the ponds were closed in 1916.

A new coral-bordered outflow was made from the Lake to the Ponds, with falls upon it, 1918.

Plan of the Botanic and Economic Gardens showing the "lawns," "areas," or "blocks" into which they are divided. The Lawns and Areas in the Botanic Garden are designated by the letters of the Alphabet. The Blocks in the lower part of the Economic Garden are designated by numbers. The position of the Gardens' building is indicated. For the fullest preservation of the amoenities of the Botanic Garden, most of the quarters are in the Economic Garden.

Changes about the sides of the Lake.

The embankment of the Lake was raised one foot, 1890.

A path through Lawn F. was made and a collection of Leguminous trees planted along it, 1889.

An oil engine was installed within a clump of trees at the junction of Lawns E. and K., by which water is supplied to the Bandstand Hill, Fernery, Propagating Yard and Plant Houses, 1907.

The islet was planted with the larger plants now on it, 1891, cleared of undergrowth and turfed 1904, but the undergrowth has returned.

A kiosk on Lawn E. was erected as a shelter, 1907.

Changes about the head of the Lake.

Cantley's mounds for ferns were planted with Sansevieras and other succulents, 1888-89; then trees sprang up on them which were suffered to remain: and when their shade was sufficient, rocks were inserted into the mounds and ferns encouraged, 1904. But as the paths were too narrow, they were reduced in number and the mounds reshaped in 1914; and a hollow walk, coral-bordered, was made upwards through the lower part of the big cistern, 1915. Two pools were constructed in this "Dell," 1915; and they were connected with the inflow from the Tyersall Lakes, in such a way that the muddy rain water from Garden Road and elsewhere should be excluded, 1918.

Changes on Lawn D.

The Aviaries were removed, 1905-07, the Monkey House being left to serve as a shelter until 1913, when it also was removed.

The Herbarium building was erected, 1903. For the history of its contents, see the Annual Report of the Gardens for 1889 and subsequent reports.

Changes on the Bandstand Hill.

A Bulb Garden was made where Cantley's series of herbaceous annuals were, 1888.

A Marantaceous border was planted behind it, 1888.

Sand was supplied first on the Bandstand for the children's play ground, 1902.

Rose beds were made round the tall palms upon the Hill, 1915.

Two additional feet were added to the breadth of the Upper Ring Road by narrowing the border drains and improving them, 1905.

The climbing Thunbergias upon the north side of the Hill, brought down their supporting trees, 1889, just as they had done in 1876, and did again in the neighbouring edge of the Gardens Jungle in 1915.

Changes about the Plant-Houses.

The roof of the Large Plant House (Exhibition House of the older reports) was modified with the object to improving the light, 1897, 1898, and 1918. Its gable was built, 1918. Its central pillar was built, 1898; the coral arch in it was built 1898; its tank was constructed, 1900.

The Annexe to the Large Plant House was built, 1889, and reconstructed 1895-96; its tables were lowered and the house altered, 1904.

Little rockeries were made just to the north west of the Annexe, 1890.

Changes in the Propagating Yard.

The old cooly-lines which were infected with Ankylostoma, were removed, 1899.

Cantley's Orchid House was removed, 1895.

The Roadway to the Propagating Yard from the Large Plant Houses was continued to the Rogie entrance, and its line through the Yard altered so as to give more room on the side where the plants are grown and less upon the side towards Cluny Road: the entrance from Cluny Road close to Lermit Road was closed, 1890.

Propagating House No. 1 was built, 1898, and reconstructed in 1911: No. 2, an old house, was reconstructed in 1896: No. 3 was built for shade plants, 1901: No. 4 was built for orchids, 1908: the Glass-roofed House No. 5, built 1898, was rebuilt in 1906; and the similar house No. 6 was built, 1908.

New unshaded tables were built east of the two glass-roofed houses, 1917 and also north of them, 1918.

A new path parallel to the Lower Ring Road was made to the Fernery, and planted with Aroids, 1889.

A collection of Scitamineae was built up under the Tampoi trees where Cantley had proposed to raise orchids, 1890 forwards.

Quarters for two carpenters built, 1907.

Changes about the Palm-Valley.

The long rectangular beds where Cantley raised flowers for bouquets were closed, 1890.

The old Monkey House was re-erected over the top of the Valley to serve as a shelter for any one caught by rain in this part of the Gardens, 1914.

The entrance to the Gardens' Jungle path was altered so as to pass it, 1914.

The pathway down the Palm Valley was converted into a road and new paths made to east and west of it (that to the west however closed again later), 1891-92.

The plantation of palms commenced by Murton at the head of the Valley, was extended down the valley, 1891 forwards.

The nursery in the hollow was enlarged, 1891.

The swamp against the Tyersall Road was converted into a Lake, the Cluny Lake, bridged for the Roadway, 1891-92. The bridge was converted into an embankment, 1894, and the embankment raised, 1896. The Lake was confined on its southern side, 1912; and the pond, cut off on its west side by the road, was filled, 1914.

Changes about the Director's house.

Beds for cut flowers at the back were changed in position, 1889 and then abandoned gradually.

Tyersall Road having been made, the old path at the back was allowed to become closed up, 1890. The upper corner of Tyersall Road was improved in 1904.

Near the Assistant Director's house, benches were placed for raising annuals, etc., 1915.

A small orchid house was constructed of the iron of the old bear cages, 1917.

A Sun rockery was constructed for Agaves, 1914.

Changes in the Economic Garden.

The Riding road was made, 1899-1900.

A roadway intended to continue the line of Garden Road through the Arboretum and be metalled for carriages, so to bring visitors to much that is of interest in this part of the Gardens, was laid down, 1915.

Blocks Nos. 1 and 3 were planted with rubber, 1886-88.

Block 2 which had been covered with forest trees left from Cantley's forest nursery, was planted with rubber, 1904.

Blocks Nos. 4 and 5 planted, 1884-87, and forwards.

Block 12 planted, 1913.

Castilloa planted in Block 14, 1900.

Ficus elastica planted with coffee in Block 11, 1905.

The Hill-sides dug, planted and returfed in sections, 1894, forwards.

The hill top towards the west planted with gutta, 1897-99.

The neighbouring slope towards Cluny road planted through under jungle with gutta, 1903.

Rubber smoke house, built, 1909.

Quarters for 3 subordinates built, 1891, rebuilt, 1908; and for another 1893: and for another, 1915: and for another 1916.

Economic Garden tool-shed built, 1907.

Economic Garden Office built, 1908.

Lines for Tamil coolies built, 1892; rebuilt 1910, and extended, 1918.

Lines for Javanese coolies built, 1899, and extended, 1918.

Lines for watchmen built, 1899; rebuilt, 1910.

Quarters for an Assistant Curator built, 1910.